

The Role of Urban Pattern Indicators for Sustainable Urban Forms in the Developed Countries

A Pragmatic Evaluation of Two Sustainable Urban Contexts

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Abstract- Since cities are constantly changing, their new forms activities are developed according to their patterns and physical arrangements. Sustainable urban form is currently a widely discussed topic in the concept of urban sustainability. The physical built form of cities can be conceptualised as two interlocking planes. The first is the spatial distribution of activities and buildings. The second element is the pattern of streets, parks and the public realm. Sustainable integration between these layers lead to a compatible built environment. This paper intends to formulate sustainable urban form indicators as a conceptual framework model which provides a comprehensive understanding of how sustainability can be evaluated and measured according to the pattern of any built environment. This framework consists of eight indicators: Accessibility, Connectivity, Compatibility, Diversity, Nodality, Density, Identity, and Adaptability. Accordingly, two of the most significant sustainable urban district has been chosen as a field study. The first is Hammerby residential district in Stockholm of Sweden, and the other is Vauban residential district in Freiburg of Germany. The research concludes that the high quality performance of urban pattern indicators in the developed communities may motivate, inform and improve the design strategies in order to achieve a more sustainable urban context.

Keywords- *urban patterns; sustainable urban form; developed countries; Hammarby; Vauban*

I. INTRODUCTION

Urbanisation, the rapid growth of population, the economic inflation, environmental changes, and social equity related to sustainable urban development have become the main focus of many scholars and much literature. Many significant attempts

to resolve these issues have theoretically and virtually been achieved in the developed countries like United Kingdom, Germany and Sweden. Many local governments in these regions have formulated urban development policies and plans at all levels and integrated all these issues and considerations into holistic urban development planning efforts [1].

Regarding sustainable cities, much literature that has emerged from the growing debate around sustainable urban form describes a number of various approaches being considered and develops a variety of paradigms of sustainable urban form, which represent significantly different views of how these concepts are emerged and practiced globally. Literature has indicated the significance of the patterns of building arrangements, the unsustainable growth of cities in developed countries and their link to urban forms. Many cities in developing countries are currently undergoing a similar economic growth and urban development to that experienced by developed countries in the last century [2]. It is very important to guide these cities to develop in a sustainable way to protect the global environment from any further harm.

This paper aims to identify urban pattern indicators, which are emphasised the most by scholars and literature, evaluates their performance in two different sustainable contexts, and formulates a set of practical recommendations for local architects and planners to enhance the local built environment.

II. SUSTAINABLE URBAN FORM

The world is in the midst of a disturbing period of growing consumption, population, and environmental deterioration.

From global warming to biodiversity loss to patterns of sprawling land consumption, the environmental trends are increasingly dire. Thus, cities in both developing and developed countries are involved and seen to be important in the realisation of sustainable urban development [3]. Physical sustainability is considered one of the significant parts of the sustainable urban development [Fig. 1]. It is the process of improving the built environment to meet people's requirements whilst avoiding unacceptable economic growth and social or environmental impact.

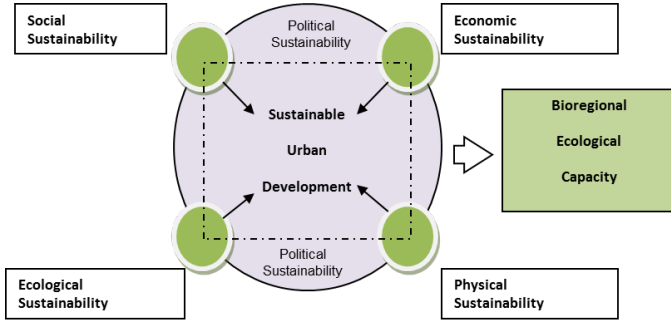


Figure 1. Physical Sustainability in the Sustainable Urban Development Map

One of the objectives of a sustainable built environment is to ensure that urban development is compatible with the natural environment and social principles so that the relationship between them is balanced and mutually enhanced. It would seem that a sustainable urban form could be defined as a form which depends on non-renewable resources, that is 'user-friendly' for residents and desirable as a place to live [4]. Other scholars and researchers described the sustainable city and urban form as follows: sustainable cities are cities that ensure well-being and a good quality of life for inhabitants who are treated equally, are environmentally friendly and socially integrated [5].

III. URBAN PATTERN INDICATORS

Defining and measuring sustainable urban forms which is sometimes termed 'sustainable urban neighbourhoods', 'sustainable urbanism' or 'sustainable community', has significantly progressed over the past two decades [6]. Many scholars have demonstrated the importance of these indicators and dimensions and how they may play a major role in the process of evaluating cities and communities deemed to be the most sustainable. Furthermore, using spatial representation of indicators of sustainable urban forms is a means of assessing the nature of the urban structure, ensuring direct implication to issues of quality of life, physical design and urban form [7]. According to many researchers and much literature, eight significant indicators can be identified to measure and evaluate urban forms and their patterns in the context of sustainability: Accessibility, Connectivity, Compatibility, Diversity, Nodality, Density, Identity and Adaptability.

A. Accessibility

Accessibility is considered an essential indicator for achieving sustainable cities. Many scholars have noticeably described the relationship between accessibility and sustainable urban forms. Burton and Mitchell, [8] indicate the meaning of accessibility as urban efficiency, equity and sustainability as well as the extent to which people have the means to access places, services and facilities outside their local area. Related to this, sustainable urban form is defined by the degree to which it supports a friendly and car-free built environment. Therefore, many other scholars have connected high accessibility with reducing the dependence on vehicles. Masnawi [9] describes a sustainable city as a settlement which has good and equal accessibility to the amenities and services of the city. Recently, measures of access have been used extensively as part of an effort to evaluate the built environment for health effects. Talen [10] argues that walkable access to services is an essential part of the sustainability equation because people living in well-served locations will tend to have lower carbon emissions. Therefore, accessibility in walking distance to local services and facilities should include public transport nodes/stops with distances between them of 400-800m.

B. Connectivity

The organisation of urban form and building pattern has an exclusive interrelationship with the movement network system. Therefore, the emerging focus on designing sustainable urban forms and the arrangement of buildings reflects the diversity of contemporary requirements for highly connected and permeable built environments. Hence, urban connectivity refers to how urban blocks and spaces are connected within the district and with adjacent neighbourhoods visually and physically [9]. Carmona adds as an urban form vision, increasing connectivity translates to smaller block perimeter, more street intersections, fewer dead-end streets and cul-de-sacs, creation of central places where multiple activities and facilities are provided that promote a liveable and sustainable neighbourhood [11]. Song and Knaap [12] have developed four measures of connectivity which involve the number of nodes and intersections: internal connectivity, block perimeter, blocks, and cul-de-sac length.

C. Compatibility

Urban compatibility refers to the capability of urban form to be homogenous and harmonic with the surrounding buildings and open spaces. Scheel [13] also defines compatibility as maintaining harmony, balance, and unity of forms and patterns of buildings. Therefore, the planning and arranging of building masses as part of an urban network emphasising not only reformation of the existing fabric, but also the development of new, compatible structures, which can create cohesive cities and promote urban sustainability. Many

scholars and much literature have interpreted the notion of urban compatibility, features, and requirements for obtaining good cities or sustainable urban forms. Lynch [14] summarises these requirements in five aspects. They are called performance dimensions and can be identified as the following: vitality (liveability), sense (identity), fit (congruence), accessibility (openness), and control (stability). These qualities are about the appearance and compatibility of places. Neuman [15] adds more aspects to enhance the physical appearance of the built environment. Features like: visual appropriateness, harmony and richness can be interpreted easily by many people and create satisfying sensory experiences. Finally, Scheel [13] adds even more characteristics to enrich the urban compatibility. He describes elements like; sense of human scale, legibility and, as well as imageability of the built form of the neighbourhood, improved access, perception and comprehension of the built form, which would eventually establish a better quality of life.

D. Diversity

Undoubtedly, diversity is considered one of the significant indicators in achieving sustainable cities. Community stability is enhanced if the neighbourhood consists of a variety of house types, daily services and facilities, and a mix of tenures. Big cities in developed and developing countries are characterised by numerous diverse and intense connections and activities; where people live, work, shop and play. This provides high levels of vitality and vibrancy and attains the needs of economic and social reproduction [16]. Most scholars and planners have intensively identified the role of urban diversity in creating sustainable communities. Sassi [17] describes the ideal neighbourhood as the one which has efficient public transport; a well-defined human scale; diverse shops and facilities; and high quality of life. Moughton [18] argues that sustainable urban pattern approaches have focused recently on providing and encouraging the main attractions of city living, services or mixed-use facilities adjacent to citizens residence, horizontally in the same street or vertically in the same building.

E. Nodality and Containment

The creation of accessible, social, and liveable nodes and open spaces is one of the significant dimensions in achieving sustainable urban forms. The articulation of buildings and the surrounding spaces creates valuable nodes which should be strongly considered in the planning and design process. At a neighbourhood level, Frey [19] believes that sustainable urban form is interrelated with mono-centric or poly-centric models of urbanism where urban growth and building organisation are created around sustainable nodes. In addition, Talen [10] indicates the important role of neighbourhood open spaces and nodes in achieving sustainable communities. She describes the nodes and the containment of blocks as a small paradigm of

“community” where residents share various activities and communicate. This would substantially promote the sustainable built environment concept. Planners and architects, when measuring urban nodes and urban spaces, are in need of an appropriate perception of the principles, and the factors affecting these spaces in order to establish an authentic connection between the people, spaces and the buildings. Porta argues that the degree of centrality is the simplest definition of node centrality. It is based on the idea that important nodes have the largest number of ties to other nodes in the district [20].

F. Density

Density is another essential component and an important characteristic in definitions of sustainable urban form. There is a common agreement among scholars that high density and compactness of buildings lead to more sustainable cities [21]. Many scholars indicate the role and importance of compactness, density, mass proximity, intensification, and contiguity in the latest sustainable urban strategy. Jabareen [22] considers intensification which ‘uses urban land more efficiently by increasing the density’, which is a major strategy for compactness and contiguity of the built environment as essential approaches for achieving sustainable communities. Tower [23] argues that density is a measure of the number of people living on an area of land which can be a small or large area. He also adds that on a smaller scale, density may measure the population of a neighbourhood or an individual estate or development. Scholars like Dempsey, describes density measures in another way. He states that residential density may be described as the number of dwellings, bed spaces or habitable rooms per hectare, acre or square kilometre; while building density may be described via plot area, floor area ratio or ratio of open to built-up space [5].

G. Urban Identity

The sustainable city is one that basically lasts through the ages, which has the ability to restore it-self. Therefore, one of the crucial definitions of sustainability is the equitable preservation of the built and natural environments, cultural heritages, and economic opportunities and encouragement to generate and protect the sense of place and identity of the city [1]. Hence, creating distinctiveness and preserving a unique and memorable sense of a place and making changes to the urban fabric that complement or enhance the character and human appeal of a place is considered an important dimension for a good sustainable city [7]. Moreover, integrating historical features and traditional characteristics in modern planning has proven effective in maintaining the distinctive character of sustainable cities, more specifically in places which have a rich history [24]. Urban identity was measured in previous research by identifying the amount of meaning

attached to a place. Scholars and researchers identified different factors, elements and indicators to measure the urban identity of a place like physical features, activities, and the available signs and symbols.

H. Adaptability

For many communities, surviving in a polluted world along with social, economic and political issues will be an enormous challenge. The quest for adaptable population, management and urban strategies is one of the ultimate demands of sustainable cities [6]. Many scholars indicate the significant role of adaptability, futurity and resilience as crucial factors in achieving long-lasting cities. Masnavi lists four underlying principles of sustainable urban development: environment, equity, participation, and adaptability [9]. Accordingly, many scholars have attempted to define urban futurity and resilience depending on their research areas. Bristow [25] defines urban resilience as the ability of city systems to resist, absorb and tolerate alteration in a well-timed and efficient manner before adjusting around a new set of structures and processes. This means basically the preservation and restoration of the city's essential basic structures and functions.

IV. RESEARCH METHODOLOGY

This paper has adopted a qualitative case study survey which included the observational and analytic study of the urban form of two residential districts in Sweden and Germany. This study covered site visits, observation, checking, comparing and documenting of various existing urban projects. The purpose of the observational study is to explore, explain, and describe the pattern and organisation of the current built environment. Each of the indicators was measured and analysed separately to examine its performance and impact in comparison to the other dimensions. Finally, relevant discussion and practical recommendation were submitted to review the performance of the indicators and to enhance the local built.

V. CASE STUDIES

This section reviews the initial identification of two existing potential residential case studies. Each example is selected to cover a broad variation of urban form within a specified sustainable development.

A. Hammarby City in Stockholm, Sweden

Hammarby Sjöstad, in Stockholm is one of the most ambitious sustainable development projects in the world. The City of Stockholm has described the area as one of the world's highest profile examples of sustainable city development. The green inner-city district is built to the south of Stockholm in 1995 on land formerly and currently is used by the port. Stockholm City Planning Bureau has worked on the master plan to occupy an area of about 200 hectares [Fig.2 and 3],

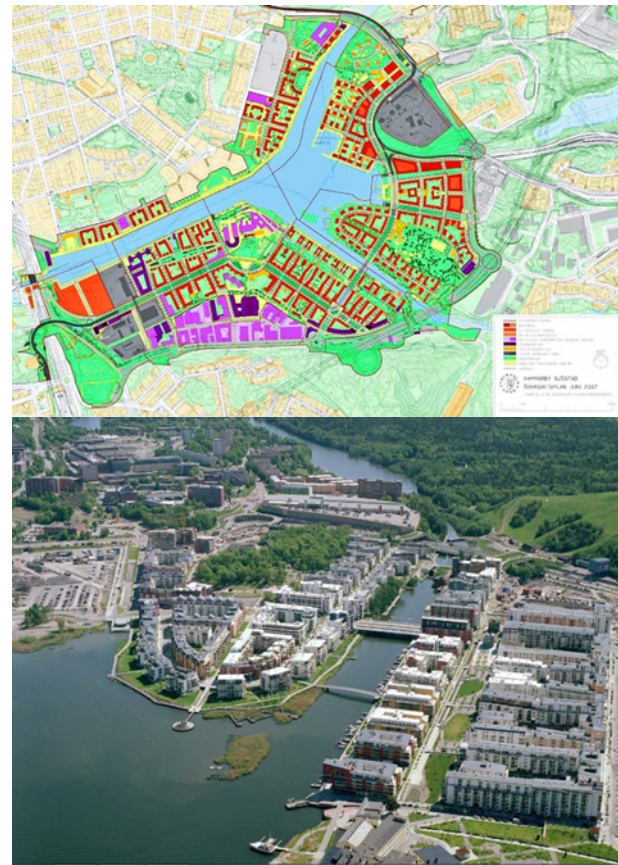


Figure 2 - 3. Master Plan and Aerial View of the District, Hammarby

Source: (City of Stockholm, 2006)

which, according to the master plan, will comprise 11,000 apartments, for about 25,000 residents, and an additional 200,000 m2 area of commercial space by the year 2018.

The urban planning and building arrangement for the neighbourhood has ensured diversity in architecture, a fine grain, texture and human scale. In particular, the way in which the master plan area has been divided into sub-areas, as linear and clustered pattern organisation to ensure the highest intimacy and containment. Each of these sub-areas was the subject of a cooperative design process ensuring that a variety of different architects were involved, but all working within the context of the master plan and its design codes has helped to ensure both unity at a strategic level, harmony of building collaboration and variety of details. According to literature and site observation conducted by the researcher, an assessment of the district has been achieved depending on the performance of the urban pattern indicators [Appendix.1].

B. Vauban District in Freiburg, Germany

Freiburg is known as the 'Green City', hosting 408 hectares of parks, green areas and playgrounds with its new green

settlements/eco-suburbs of Vauban and Rieselfeld. The Vauban Quarter was created (1998-2010) on an area of 41ha located 3 km to the south of the city centre [Fig.4 and 5], on terrain where social and ecological concepts were integrated through the planning and development of what used to be the site of a military base. Right from the beginning all issues (mobility, energy, housing, social aspects etc.) were discussed in working groups which were open to residents. Many scholars have studied and analysed the district since it represents a distinguished example of sustainable urban development.

The development plan for Vauban has included some regulations for the design and layout of the homes. These included the prohibition of detached houses, thus leading to a compact urban building structure and the prohibition of buildings exceeding four storeys. The pattern of buildings has emphasised a linear-grid arrangement to achieve variety and distinctiveness and this has been encouraged through the preferential allocation of land to private builders and co-operative building projects. This is illustrated by the numerous individually designed façades, which create a special atmosphere. A similar assessment has been conducted to show the performance of the indicators [Appendix.1].



Figure 4 – 5. Master plan and Vauban District Arial View

Source: (Freiburg City Council, 2008)

VI. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Planners and urban designers should ask themselves whether they can shape districts and towns through the development of patterns of structures, public spaces, set of squares, streets, urban frameworks and other public places as component of the character and functioning of our neighbourhoods. The final evaluation of Hammarby and Vauban districts in terms of urban pattern indicators indicated remarkable and significant aspects [Fig.6].

The translation of these performances can be summarised as followings:

- Accessibility: Hammarby district is accessible from all directions to provide high connectivity and reduce traffic congestion. Daily needs, facilities and public transportation stations are accessible within max 10 min. of walking which promotes walking and decreases the use of private vehicles. In Vauban district, a hierarchy of roads are available to provide permeable and accessible destinations. The district can be easily reached from the nearby main roads. Both the city centre and rail station are accessible in about 12 minutes with comfortable and well-protected sidewalks.

- Connectivity: in the first district, the connectivity, proximity and visual permeability among the blocks are highly valued. However, linkage with other neighbourhoods needs substantially more identified and cohesive corridors. In the Second district, Permeability and connectivity are highly encouraged through efficient planning of the pathway network. Visual and physical connectivity are utilised through creating safety corridors among the blocks.

- Compatibility: The mass-void relation, contiguity and legibility are thoroughly studied and designed in Hammarby. Although the project has been designed by various architectural offices, the general theme, unity and architectural rhythm of the building have been arranged with spectacular harmony. While in Vauban, the Massing and architectural treatment is moderately simple and restrained, often enlivened with colour and with planting draping over balconies.

- Diversity: The first area has diverse building floors (apartments over 4-8 floors).The ground floors of nearly all the buildings along the main corridor have been designed as flexible spaces, suitable for retail, leisure or community use. However, the area lacks a few daily needs and good competitive stores. In the second area, the inter-mixing of housing, shops, restaurants, workplaces, social centre, and other activities places many destinations close together, thus inviting more walking and bicycling.

- Nodality: in Hammarby, a network of varied parks, green spaces and walkways runs through the district to provide a

counterbalance to the dense urban landscape. The open spaces and activity nodes evolve along movement patterns with intimate enclosures by the urban blocks and visual interaction between residents and visitors. In Vauban the articulation of buildings and the arrangement of the urban pattern are relatively simple and create proportionate open spaces. The spaces between the buildings are as important as the buildings themselves and have been designed with great care and attention to detail.

- Density: The first district is a concentrated residential area with compact buildings with five storeys on average, but with reasonably spacious green courtyards. The grains, contiguity and the proportions are thoroughly designed. While Vauban's density supports a diverse compact array of neighbourhood businesses, transit infrastructure and community gatherings and hence offers a better quality of life than existing suburbs.

- Identity: In Hammarby, the designers had set out to create a very characteristic and specific identity which related very directly to the scale and grain of the city centre of Stockholm, re-interpreted in a modern style. Urban identity in Vauban has no specific local uniqueness, history or landmarks. However, eleven blocks of the former barracks were preserved and renovated to keep the identity and characteristics of the old district.

- Adaptability: The location, orientation, and district management are important futurity urban planning tools that are already well- identified in Hammarby Sjöstad. However, this project lacked participation of the users in planning processes and the interaction between inhabitants and their willingness to change behaviour towards environmental responsibility and conservation. In Vauban, residents were closely engaged in the development process at every level and continue to be involved in running the district which ensures they are still closely engaged in the development process at every level. However, the location and the orientation of the building have less significant sustainable characteristics.

According to the previous discussion, the main conclusions are clarified as the following:

-Accessibility: The aim of this indicator is to analyse provision of accessible streets and pathways to places and spaces and if they are well-defined, safe, and direct. This dimension has indicated high values in both districts. However, the accessibility of the local services and facilities has shown low values in both areas. This issue has been the main concern of the local residents in both areas.

- Connectivity: This aspect is considered one of the main cores of achieving social and physical sustainability. According to the data analysis, this feature has been well-defined internally and needs more intention regarding the connection with the neighbouring districts. However, street hierarchy, permeability, and visual connectivity are efficiently designed.

- Compatibility: This indicator is provided by designers and planners to achieve a high quality neighbourhood design and compatible built environment. According to the analysis, the current built environment in both districts has indicated characteristics of harmony between: the massing and the surroundings, façade design and local context, and human scale and the provided open spaces.

- Diversity: This aspects registered lower values due to the shortage in daily needs. However, diversity is not merely related to providing basic needs, but also to the ability to achieve liveable, vibrant and social places. These districts have succeeded in attracting visitors from other districts due to the attractive social places. Diverse transportation and building types have added extra credit to the areas.

- Nodality: This indicator has indicated high values among the others. The design of nodes, open spaces and pedestrian pathways are professionally regarded. Moreover, the provision of social public spaces and children playground has been well considered. However, there are a few issues which need more attention like privacy and provide more spaces for visitor's car parking.

- Density: the creation of compact, diverse, and well-defined urban fabric is an important dimension in achieving sustainable urban form. The results have remarkably shown that this element has been well-achieved in both areas. Furthermore, as mentioned earlier, diverse building type was an important factor in the selection of these projects. The spatial arrangement of the buildings inclusively refers to the proper layout of the blocks horizontally and vertically. In this sense, the current patterns of the residential projects have significantly attain a high standard of solid and void mass, positive and negative space, human scale and building contiguity requirements.

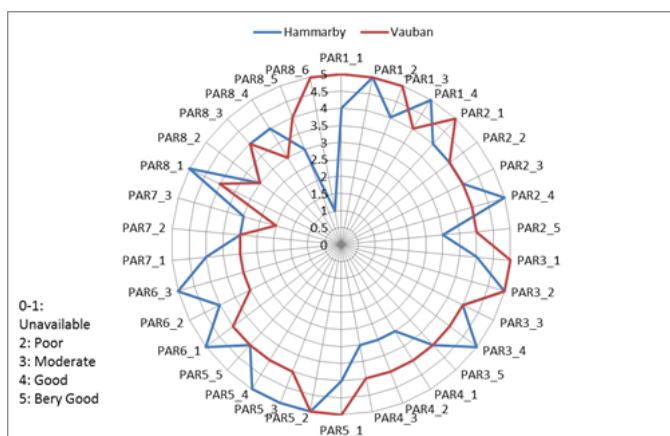


Figure 6. Indicators Performance in both Districts

- Identity: This aspect is considered one of the essential indicators to achieve sustainable communities. The modern architectural style and re-used construction materials in both areas have awarded them a distinctive presence, considered and devised them within the appropriate context, culturally and environmentally. In addition, the designers have given primacy to achieve identifiable nodes and public domains which are comprised of unique memorised outdoor spaces which are compatible with the quality and identity of each city.

- Adaptability: As discussed earlier, long term adaptability is one of the most significant dimensions in promoting long-lasting built environments. According to the results, the project management and resilience indication have been well-achieved. However, the importance of citizen's involvement in the planning process is regarded as an important aspect participation in decision making helps people to develop a holistic consensus regarding the enormous issues of their communities.

Finally, a set of recommendations are presented to enhance the local built fabric in terms of urban pattern and its impact on achieving sustainable urban forms as follows:

- Improve the overall access to local services and public facilities within the residential neighbourhood. Moreover, provide direct (as much as possible), safe, and convenient pathways between residential blocks (private zones) and these public facilities (public zones).

- The street network and internal corridors should provide a high level of connectivity between the internal blocks on the one hand and with other adjacent neighbourhoods on the other hand.

- Harmony, scale, proportions, colours, materials and the architectural design of the new districts could be adopted to integrate more coherently, with diverse local context.

- Provide all the important facilities, adequate services and competitive daily needs within accessible locations and adequate safe distances in one hand and Increase the residents' awareness to utilise district's services to increase the vitality and liveability of the local neighbourhood.

- To improve community wellbeing the planning, urban pattern and detailed design of new residential villages should include appropriate connected nodes of open spaces and green areas which encourage physical, social and cultural activities.

- Provide a variety of housing types and densities particularly around activity centres and public transport nodes to encourage diverse and integrated communities.

- The preservation of urban identity and the community's sense of place through the use of physical and historical features which reflex the local character and city image.

- The appropriate orientation, alignment and dimension of the site, buildings and the streets to create energy efficient residential blocks which can minimise energy use and respond to the local climatic conditions.

- Participation is sustainability, hence, it is totally essential to encourage beneficiaries to participate in the planning and design process. The participation should not be limited to information, but to an active involvement by all residents in the urban development and in the decision making process.

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APPENDIX 1, Indicator Performance Check-List

Indicators		Scale				
		V. Good	Good	Moderate	weak	Unavailable
1- Accessibility	Access to					
PAR 1-1	Local Services					
PAR 1-2	Public Transportation					
PAR 1-3	Public Spaces					
PAR 1-4	Buildings					
2- Connectivity						
PAR 2-1	Internal Connectivity					
PAR 2-2	Blocks Perimeter					
PAR 2-3	Blocks					
PAR 2-4	Col-de-Sac					
PAR 2-5	with other Districts					
3- Compatibility						
PAR 3-1	Unity					
PAR 3-2	Imagability					
PAR 3-3	Richness and Control					
PAR 3-4	Fitness and Harmony					
PAR 3-5	Legibility					
4- Diversity						
PAR 4-1	Mix of Uses					
PAR 4-2	Vitality					
PAR 4-3	Vibrancy					
5- Containment						
PAR 5-1	Privacy					
PAR 5-2	Safety and Security					
PAR 5-3	Scale and Proportion					
PAR 5-4	Design and Landscape					
PAR 5-5	Social Cohesion					
6- Density						
PAR 6-1	Building Density					
PAR 6-2	Population Density					
PAR 6-3	Contiguity					
7- Identity						
PAR 7-1	Physical Features					
PAR 7-2	Dynamic Activities					
PAR 7-3	Meaning and Symbols					
8- Adaptability						
PAR 8-1	Location					
PAR 8-2	Orientation					
PAR 8-3	Robustness					
PAR 8-4	Amenities					
PAR 8-5	Management					
PAR 8-6	Public Participation					
Total Score						